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ON THE COVER:
Drilling to new depths of hot granite is progressing at the Laboratory's Fenton Hill geothermal site, as the photograph by Bill Jack Rodgers makes clear. Four stories on the hot, dry rock program follow in this issue.

Preview:

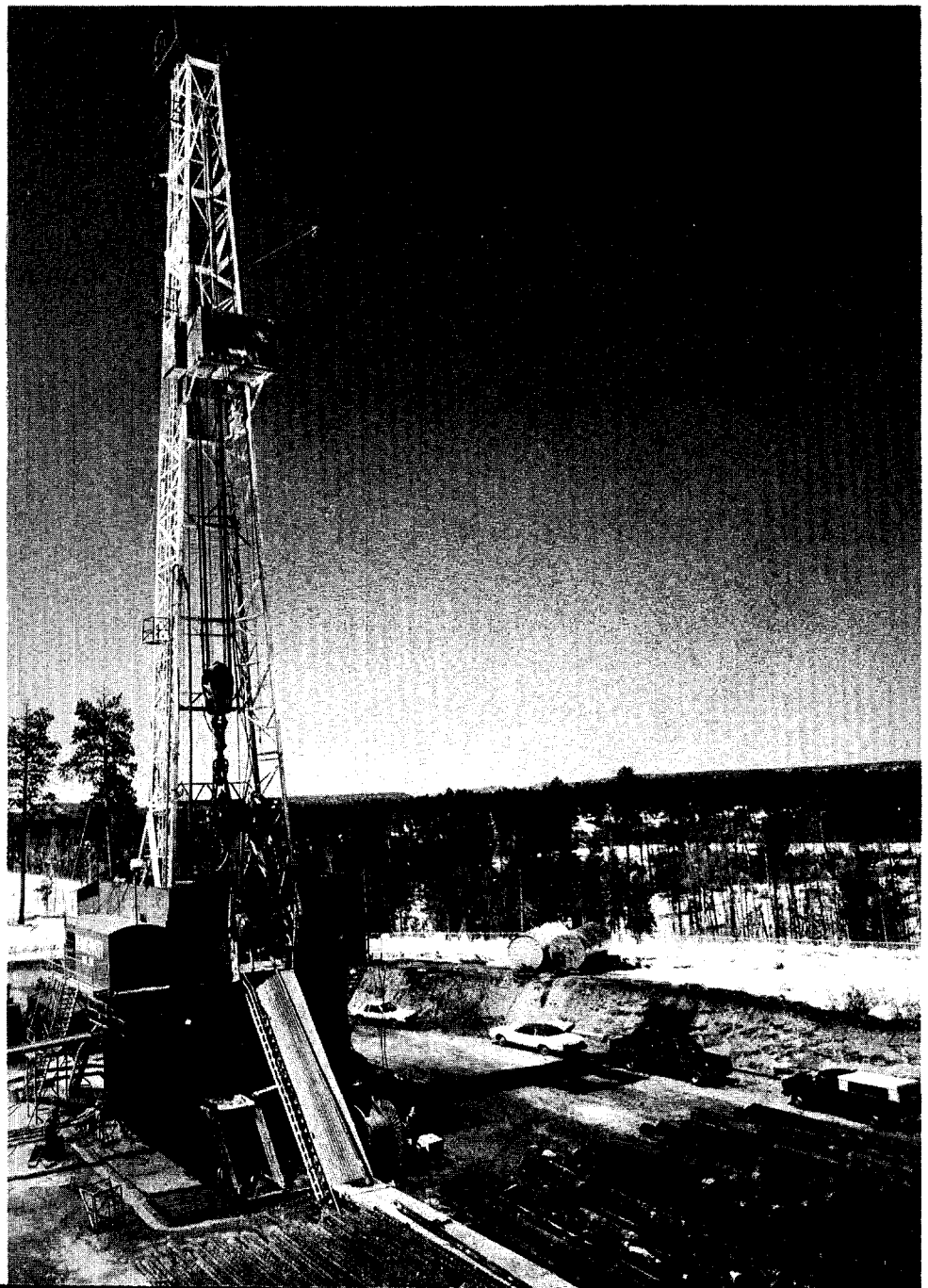
The Laboratory demonstrated for the first time ever that technically, energy could be produced from hot, dry rock beneath the earth's surface. That was in 1977; today, round-the-clock drilling proceeds at the Fenton Hill site in the Jemez Mountains as researchers head toward 13,000 feet down, about 3,000 more feet than the present underground reservoir.

To report on the geothermal progress, John Ahearne visited the site and talked with Bob Hendron, manager of the Jemez Mountains operation. Dannie Jones Harvey spoke with Mort Smith, one of three persons to originally advance the concept of hot, dry rock power. The others in a series of stories this month are by Vic Hogsett. He spoke to visitors from Thailand, one of many countries expressing interest in the LASL effort, and wrote of a promising area in Arizona...

Fifteen years ago, the LASL Cooperative Education Program started out on a low key. Today, it cannot accept all of the undergraduates who would like to "earn as they learn." A story on the program, highlighting five students who are now here, begins on page 16...

We have many colloquium speakers here each year, and one recent talk is condensed on page 23. It deals with world poverty and malnutrition...

Fenton Hill: drilling for energy at 13,000 feet



It will take six months to complete the new drilling at Fenton Hill, where LASL plans to create a series of fractures in hot granite.

Photos by Bill Jack Rodgers

By John Ahearne

All forms of geothermal energy development, not just hot dry rock, are unique in the economics of power generation.

When utility company investors finance a more conventional generating plant, they can bring in the necessary fuel to produce electricity during the life of the plant — coal, oil, uranium, natural gas.

But in a geothermal-powered operation, the builders are, in essence, buying all of the fuel for the life of the plant right when the first borehole is begun and the first yard of concrete poured.

Corporations are not likely to put up millions of dollars for a power plant without being convinced that the geothermal "fuel" will be enough to last the 30-or-so-year lifespan of the facility.

In the hot dry rock brand of geothermal energy being pioneered by LASL's Geosciences Division (G-Division), industry is waiting to be convinced.

Los Alamos scientists and engineers have already shown that they can extract heat from the granite beds a couple of miles below northern New Mexico's Jemez Mountains.

With a new project at the Fenton Hill site there, they hope to prove that enough heat for enough time can be extracted to justify huge industry investment.

From 10,000 to 13,000 feet

In the first experiment, G-Division researchers drilled into 200-degree (Celsius) granite at 10,000 feet where they hydraulically fractured an 8,000-square-meter, coin-shaped reservoir of rock. A second borehole was drilled to intersect the reservoir.

Heat was extracted from the rock by circulating pressurized water down one hole, through the reservoir (where heat is transferred to the water), back up the second hole, through a surface heat extraction system, and back down the first hole. The closed loop system operated more than 2,800 hours in 1977 and 1978.

The researchers have continued to study the thermal, chemical, and mechanical properties of the overall system, but the successes of the experiment already have demonstrated the scientific feasibility of the hot, dry rock concept.

The new project will reach deeper into the earth, where temperatures are hotter, create a series (rather than one) of fractures, and experiment with methods of insuring that heat extraction can be constant and long-lived.

LASL has contracted Brinkerhoff-Signal, a Denver-based drilling company, to bore into the tuff and granite under Fenton Hill more than 13,000 feet, where temperatures reach 250 degrees Celsius.

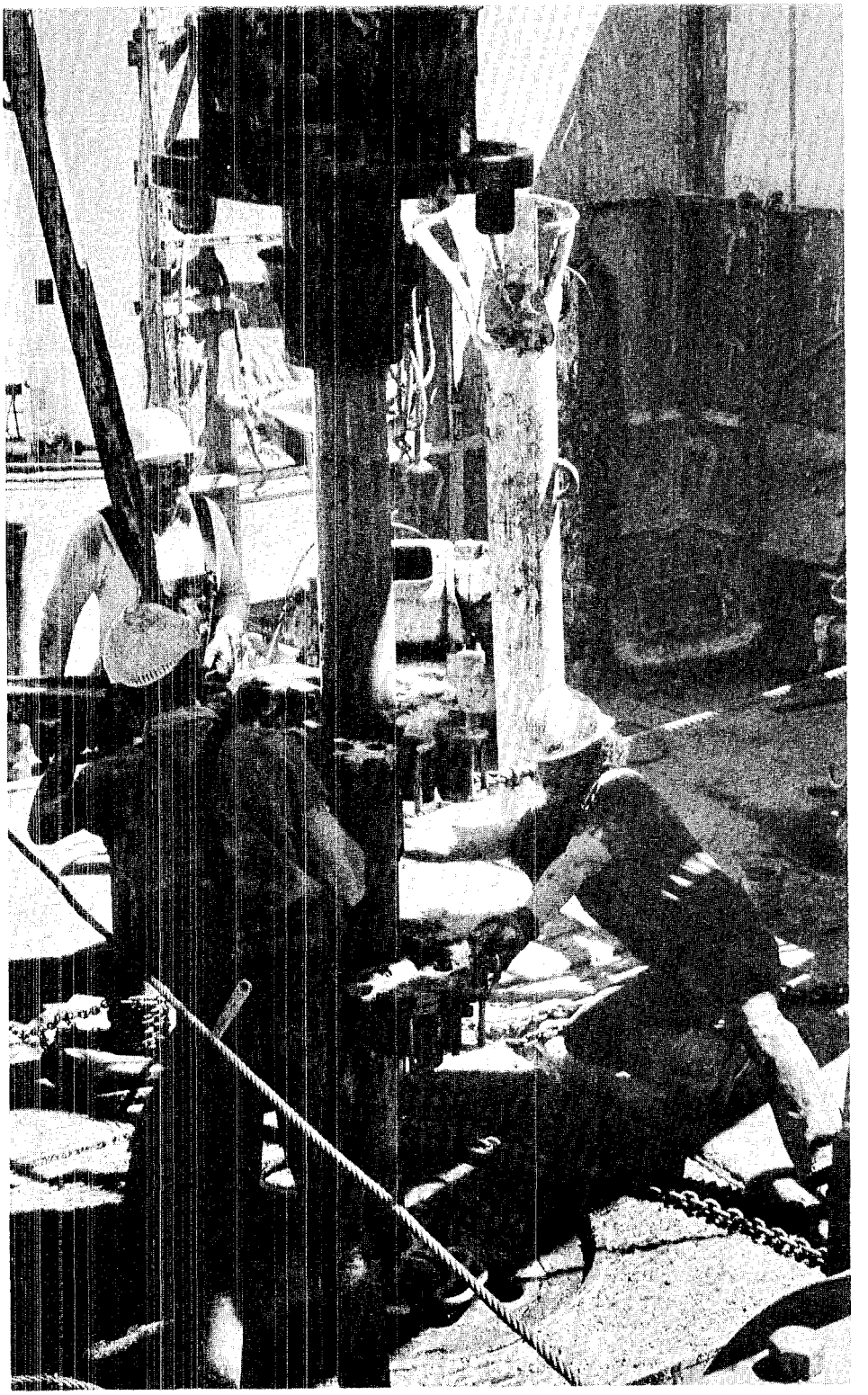
The massive, portable (3 dozen truckloads of gear), red, white, and black "Rig 56" rumbles and shakes around the clock drilling, in 30-foot sections, about 100 feet a day. Drilling costs are $7,000 to $8,000 a day.

The torque of the rig halts only momentarily when the finely choreographed crew of roustabouts moves quickly and deliberately amid the wrist-thick cables, taut chains, tubs of lubricating oil, and din of Rig 56 to insert the next 30 feet of downhole pipe.

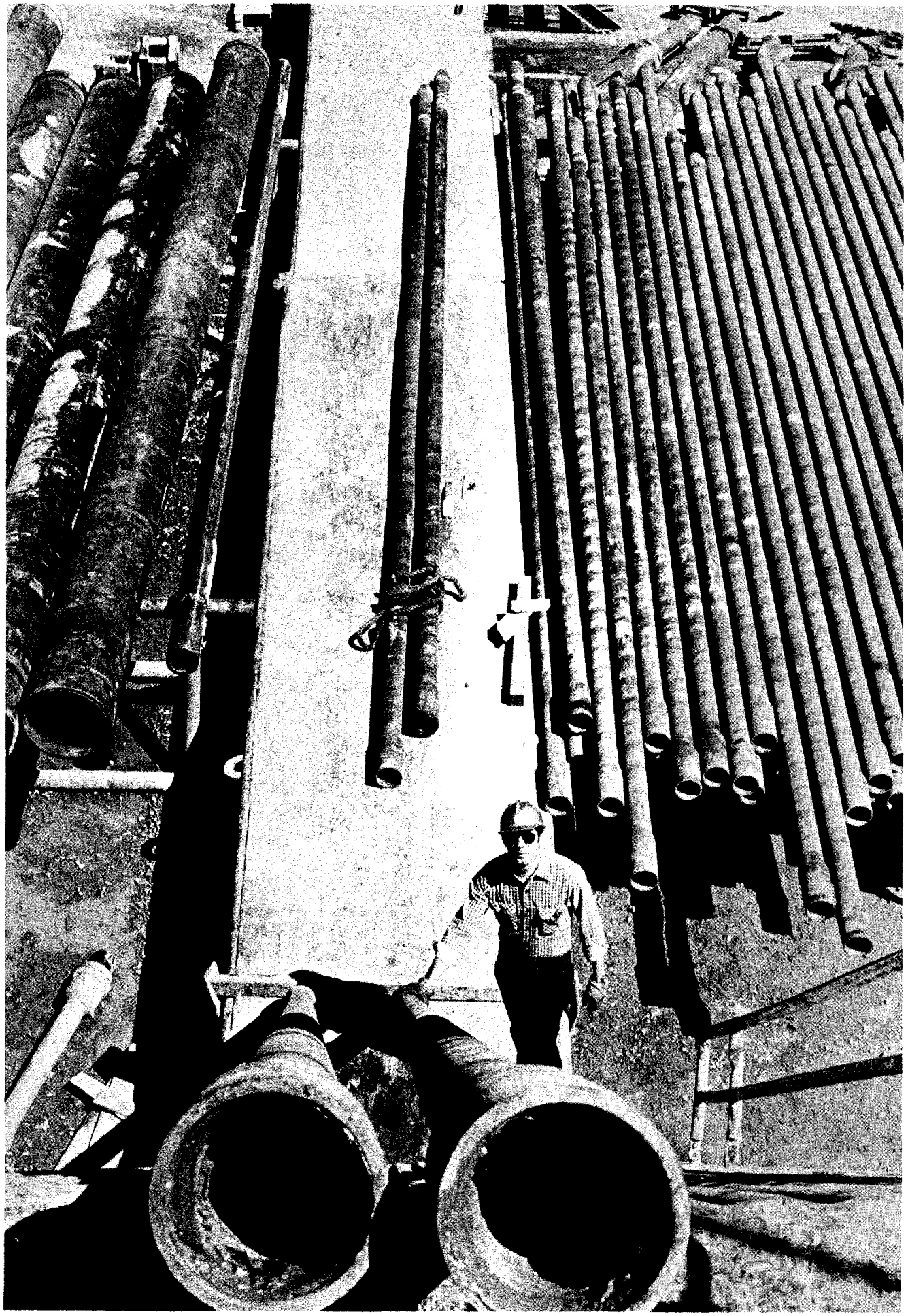
The borehole, 26 inches in diameter at the top tapering to 12¼ inches at the bottom, will take six months to complete.

As in the first closed loop system, the new project will require a second borehole intersecting the reservoirs near the base of the first. The second borehole will be a redrilling and extension of one of the existing holes.

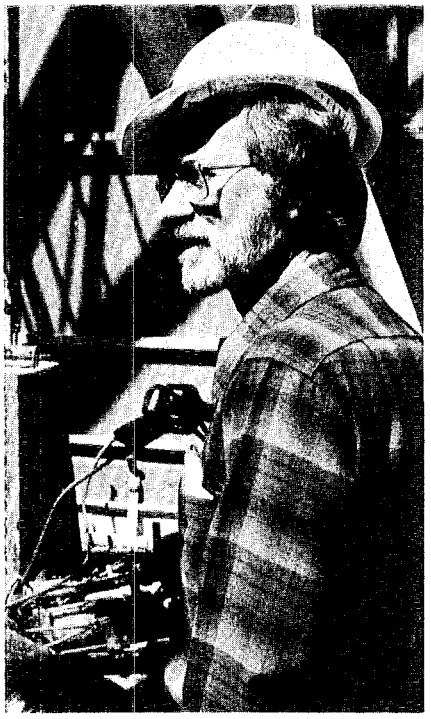
(G-Division scientists calculated that the distance between boreholes in the new project had to be greater than in the first experiment. There-



The concept of extracting energy from hot, dry rock was proven at Fenton Hill in 1977. Researchers are now going deeper, to 13,000 feet, to prove enough heat is available for industrial enterprises.



'Rig 56' shakes around the clock, drilling about 100 feet a day. It halts only momentarily to accept the next 30 feet of pipe.



Work proceeds at a steady pace, 24 hours a day, at Fenton Hill. Left, stacked pipes await the drill rig. Above left, Dan Miles of Group G-9 inspects borehole samples. Above right, site manager Bob Hendron of Group G-4 is concerned with thermal stress cracking—caused by temperature changes.

fore, at least one new hole had to be drilled.)

The deeper holes, higher temperatures, and added reservoirs of fractured rock are vital steps in demonstrating the stability and longevity of the heat-extraction system. But an equally important aim of the researchers is to optimize the transfer of heat downhole. Experimentation will also focus on methods of getting more heat from the rock to the water more quickly.

Study of stress cracking

One downhole process that will receive additional study, said Fenton Hill site manager Bob Hendron, is "thermal stress cracking," whereby temperature changes in the reservoir cause a network of cracks and fissures to branch out deep into the adjacent granite.

"In the first experiment, we found that rock in the reservoir was reheated by the surrounding granite slower than the heat was being removed by the water," he said. "With this project, we will upgrade the heat transfer capabilities by cooling the surrounding rock sufficiently to cause extensive thermal stress cracking.

"We expect that as the initial surface of rock cools, the granite will contract, opening cracks back into hotter regions of the rock. This will let the water extend back to the hot rock instead of waiting for the heat to conduct back through the rock to the water," he said.

Aside from the primary goal of extracting energy from hot dry rock, though, G-Division will continue the scientific and engineering studies necessary to make the energy system successful, economical, and environmentally acceptable.

Geochemistry, geophysics, heat and fluid flow technology, rock mechanics, seismology, and environmental effects are some of the scientific and engineering fields contributing to the overall success of the project.

Even the technology of deep drilling had to be expanded to accommodate the special circumstances of the project. For example, LASL had to contract to have a unique downhole turbine motor built that would withstand the high temperatures. Downhole turbines are used for directional drilling.

Goal is 5-10 MW source

When the current project is completed, said Hendron, the researchers hope to have a good enough heat source that could be capable of supporting a 5-10 megawatt generating plant (though G-Division will not be building a production power plant). A facility that size could supply electricity to between 5,000 and 10,000 people.

"With hot dry rock, a 50-megawatt plant seems to be a good economical size for a production facility," Hendron said. "That would

In thermal stress cracking, temperature changes cause a network of fissures to branch out in the adjacent granite.

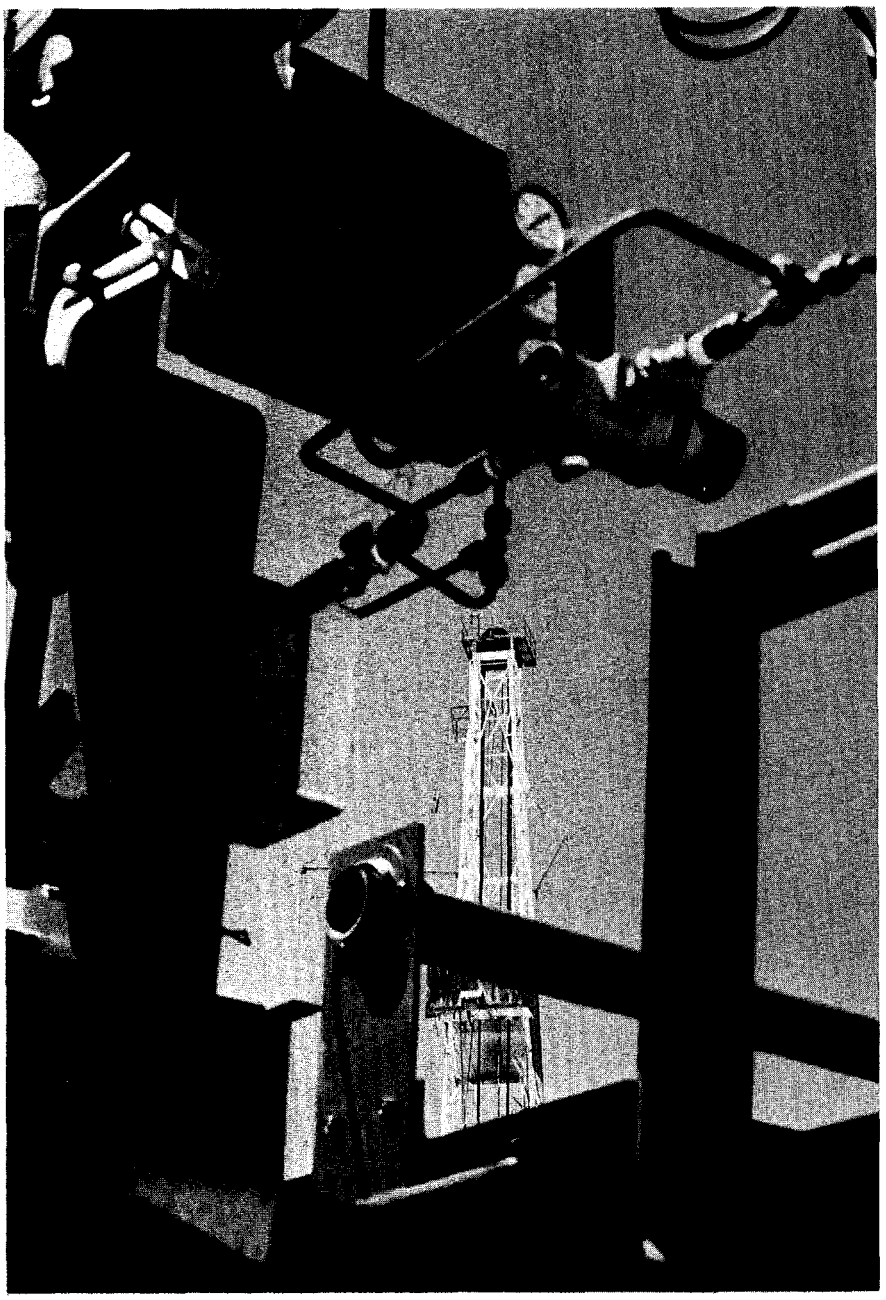
probably mean the drilling of about 10 deep holes with multiple reservoirs. Such a plant would provide electricity to about 50,000 users. We already have demonstrated scientific feasibility, and with our work with the deeper holes, hotter temperatures, and improved downhole heat transfer, engineering and economic feasibility are not far behind."

The potential is there. The energy from a 40-cubic-mile block of hot granite equals the energy from about 12 billion barrels of oil — nearly the total energy used by the United States in a year.

And the production of electricity is only one potential for hot dry rock. Researchers say that even lower temperature rock, for example, could be used for space heating, food processing, and manufacturing.

The resource is huge. The known environmental impact is negligible. The technology is being perfected.

And even though investors may have to buy all of the "fuel" with the drilling of the boreholes, that may really be a benefit — they won't have to buy any more.



The drilling tower, as seen through part of the heat exchanger at Fenton Hill. A production plant to serve 50,000 users would require about 10 deep holes with multiple underground reservoirs.

Arizona region may have potential

The Aquarius Mountains, 40 miles east of Kingman, Arizona, possess an above-average potential for geothermal energy development, according to an 18-month research study conducted by LASL. Fraser E. Goff, a spokesman for the research group, said, however, that no plans have been made to drill an exploratory well or to construct a geothermal energy facility there.

Goff, a field geologist and geochemist in the Geologic Research Group (G-6), said that LASL is currently seeking potential areas to expand the hot, dry rock research concept developed at Fenton Hill, near Los Alamos. He said LASL is interested in demonstrating the applicability of current hot, dry rock (HDR) techniques to geologic environments different from Fenton Hill. Goff indicated that the Aquarius Mountains constitute one of several sites currently being considered nationwide as possible HDR geothermal research areas.

"This (study) is an example of the kind of exploration strategy that is being used to explore for hot, dry rock for other geothermal sites," Goff said.

The study was conducted by petrologist Andrea C. Eddy, G-6's petrologist Barbara H. Arney and geophysicist Francis G. West, both of the Geological Applications group (G-5); Goff; and University of Texas geophysics consultant to LASL, Carlos Aiken.

Three interconnected disciplines were brought into play to form the basis for the study. They were geology, geophysics, and geochemistry.

Geophysical aspects of the area were compiled by West and Aiken with an eye toward possible geothermal development. The information was the result of previous research studies, oil prospecting studies, scholarly theses, and other research endeavors.

Following compilation of the existing formulation, the duo concluded that geophysical anomalies of the area indicate possible shallow heat in the earth's crust in the Aquarius Mountains region.

Previous data indicated that the area has a relatively high thermal gradient. Goff explained that a thermal gradient is the difference of temperatures through a given distance. He said the thermal gradient is often found by drilling 500-foot test holes into which heat sensing devices, called thermistors, are lowered.

The researchers said that the depth at which the Curie temperature is obtained is also significant. Technically, the Curie temperature is defined as the temperature (550° C) at which magnetic materials lose their magnetism. The team concluded that the Curie temperature in the Aquarius Mountains region was relatively shallow — a good indicator of high, close-to-the-surface temperatures.

Another test, concerned with the time it takes for teleseismic waves to be transmitted through the earth, was also conducted. The researchers concluded that seismic velocities in the Aquarius Mountains region were attenuated. Goff said that often attenuation can be caused by relatively hot (plastic) rock.

Goff also said that the relative gravity of the area was low; itself a possible indicator of shallow heat.

At the same time West and Aiken were conducting their compilation, Goff, Eddy, and Arney began their study the volcanism of the area. This study included a geochemical survey of various hot springs. They paid attention to structural settings including the location of faults, degree of faulting, age of faults, and the type of rocks involved.

"All of that kind of information is necessary background before you start drilling a multimillion-dollar hole," Goff contended. "If we actually began to plan a research site, it would be necessary to do a more detailed study of the particular site."

The three keyed on the silicic volcanism of the area. Goff explained silicic means the rock of the area is dominated by the lighter elements such as silicon, sodium, and potassium. He said that silicic volcanism was a good indication of relatively shallow heat, either now or in the past.

"We did find some silicic volcanism," Goff said. "In this particular case the problem is there was silicic volcanism, but it was relatively old — 17 million years, at least. Volcanically speaking, the area has been cooling off or has cooled off." He said that the degree of heat still remaining in the underlying rocks is more important.

The group's geochemical survey of the three local hot springs showed that the springs contained different relative concentrations of silica oxide, lithium, chloride, and boron. These data suggested that the springs originated from separate reservoirs. Chemical geothermometry indicated maximum reservoir temperatures of 115 degrees C. Several LASL scientists have indicated that 150 degrees C would be the minimum average temperature for a successful geothermal energy program.

"There are few hot springs in the area," Goff said. "They indicate no large conventional geothermal system. We're not really looking for hot water, though. We are looking for an area where the deeper rocks are still hot."

Goff added that the team is not searching for a conventional geothermal system.

"Basically we are looking for an area that would be a successful hot, dry rock site, but one that is unlike the Valles Caldera (Fenton Hill)," Goff reiterated. "We are trying to develop this (HDR) type of system in a wide variety of geologic and geothermal settings.

— **Vic Hogsett**

LASL manages the national program

(Editor's note: to present some of the political and financial aspects of the Hot, Dry Rock Program, we interviewed Mort Smith of the Geosciences Division office. He is one of the three scientists who originally advanced the concept of hot, dry rock energy and received a patent for their work. Smith also managed the HDR program until 1976.)

By Dannie Jones Harvey

What are the duties and responsibilities of your new position?

I am the deputy to Greg Nunz, who is the manager of the Hot Dry Rock Program. It's his responsibility to do the planning of the program, the coordination with Washington, the Albuquerque Operations Office, and other organizations. In his absence I perform those duties, and support him while he's here.

What is HDR?

The Hot Dry Rock Program is a program to develop the methods, the equipment, and the instruments we need to extract heat directly from the hot dry rock in the earth's crust in areas where the temperatures are high but there isn't a natural production of steam or hot water.

How is HDR used for power generation?

It's used in the same way natural steam or hot water would be used, except that we introduce the water and recover it rather than extracting what is already there... we don't expect to do anything special in the way of generating electricity... it's the heat source rather than the power plant that's different.

What is the national program for HDR?

The federal program is intended to expand the investigations we are already carrying out in the Los Alamos area to other parts of the country where the geologies are different and the techniques to extract the heat may be different too. We have to learn to modify those techniques according to the local situation we encounter.

'If we are successful, perhaps the first small power plant will be operating by 1990. A plant needs high rock temperatures that can be reached economically, and the absence of hot water or steam.'

Photos by LeRoy N. Sanchez

What are the objectives of the national program?

The principal one is to demonstrate by the middle of the 1980s that the technologies are available to extract heat from the hot crustal rock and that there is enough of the hot crustal rock available at drilling depths which we can reach... to make the technology useful in a large part of the United States.

What part will LASL play nationally?

LASL is the location of the management office for the federal program. It's part of the Laboratory organization, but in a way is an arm of the Department of Energy, because the activities that the management office will plan, support, and direct will be in many other places besides LASL as the program proceeds.

What per cent of geothermal energy will the nation be using by the year 1990?

That's hard to predict... the fraction that comes from hot dry rock will be very small by the year 1990... if we are successful in developing the technology as we hope to, perhaps the first small power plant based on HDR will be operating by 1990... and if that's successful, the industry might grow rapidly after that.

Where in the U.S. are geothermal power plants (not HDR) being planned?

They're largely in the western third of the U.S.... in the Rockies and the west coast. The nearest one, and the one farthest east, is on the Baca location west of Los Alamos. There are also power plants planned in southern Utah and in southern California.

What is the criterion for an HDR plant?

Primarily it's the existence of high temperature at depths we can drill to economically, and the absence of hot water or steam that could be recovered from drilled holes.

What are the main countries developing HDR and what connection does LASL have with them?

The major development in HDR is here in Los Alamos, but experiments in this area are being done in West Germany, England, Italy, the Soviet Union and Japan. There is interest in many other countries whose energy situation is much worse than our own. We do have a working international agreement with Italy for cooperation in the development of such systems. Informally, we have arrangements for cooperation with France and West Germany and England, and we have had visitors from many other countries. We think agreements for cooperation will be formalized with West Germany and Japan within the next few months and perhaps with the International Energy Agency, which will bring in quite a number of European countries.

Will this be an "exchange of ideas" sort of relationship?

Yes, and much of this exchange of ideas is already occurring, often informally. Visitors come here and visitors from LASL go to other countries. We are in quite close touch with other countries and we learn from them as they learn from us.... We have experience and expertise that's just being developed in other countries.

What is the importance of the new hole being drilled at Fenton Hill?

Our present system is quite small, and it was made small intentionally. We wanted it to cool down rather rapidly as we circulated water through it so that in a usefully short experimental time we could investigate its heat extraction behavior. However, it does not demonstrate that such a system would be useful for the long time required for a power plant... and we would like to guarantee a supply of heat for a period of 20 or 30 years. That will require a larger and hotter system than we have now, and we've begun to develop that by drilling deeper holes at Fenton Hill. The first one is being drilled now. We hope to drill to a depth of about 13,000 feet to get a temperature of about 250 Celsius, and a large

Nunz and Smith to geothermal posts

Gregory Nunz, assistant division leader of the Geosciences Division at the Los Alamos Scientific Laboratory, has been named to head the national Hot, Dry Rock Program (HDR).

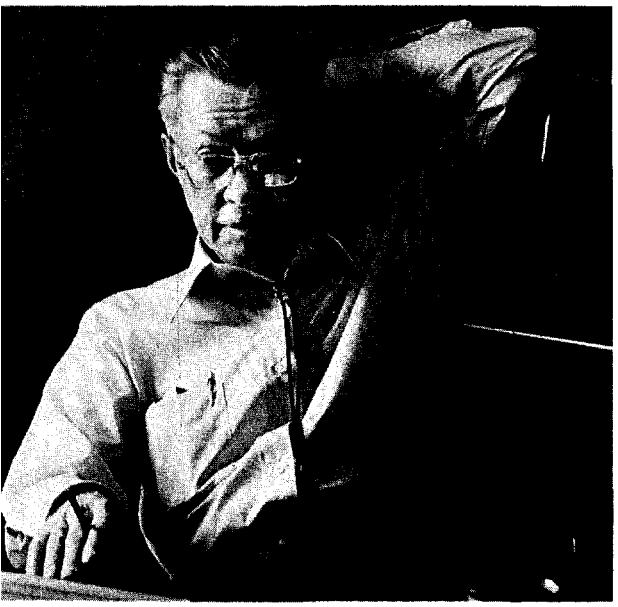
Nunz will oversee the expansion of the program from its Fenton Hill project in the Jemez Mountains to one of national scope. He will coordinate preliminary studies of possible geothermal sites in other parts of the country, and will be in charge of assessing the market potential of geothermal energy and possible environmental protection factors.

Nunz came to LASL in 1977 and succeeds Gerald Lewis, who resigned last fall.

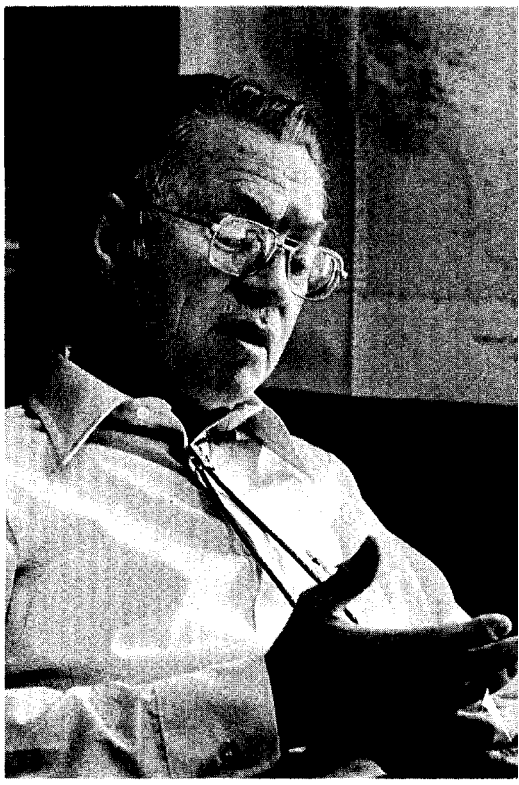
Also named to the program as deputy program manager is Morton Smith, who is interviewed in this issue of **The Atom.** He managed the LASL geothermal project from its informal beginnings in 1971 until the Geosciences Division was formed in 1976.

Nunz, an engineer, has served with Caltech Jet Propulsion Laboratory, the Bell Aerospace Corp., and Rockwell's Rocketdyne Division.

Smith, a 25-year LASL employee, received the "Distinguished Scientist of the Year" award in 1974 from the New Mexico Academy of Science.



'For fiscal year 1980, the total budget is going to be very tight. It will go to experiments at Fenton Hill, and for the exploration of interesting areas across the U.S.'



enough reservoir so that we could supply heat at a useful rate for not less than 10 years and perhaps longer.

Are there any problems with the new drilling such as environmental effects?

We do foresee problems in developing this new system — after all, we have so far developed only one. With regard to the environmental effects, this will be a completely contained system as is our present system, so we don't expect any effects such as the liberation to the atmosphere or the surface waters of any undesirable gases or dissolved solids. The water will simply remain in the operating system; in fact, we'll add to it rather than extract from it.... We don't expect any subsidence, which could be a major problem if it occured. We are concerned about the possibility of triggering earthquakes and for that reason are continuing to be careful to stay away from active faults. However, we think that the earthquake hazard is minimal, although it's not zero.

Are there any key companies that LASL is involved with at the present time?

There is a good deal of interest in the project from a great many industrial organizations. But in general, until we have demonstrated a large useful system which would last a long time, they will be happy to let the U.S. government take the risks, and watch for the results. After a demonstration of the new system at Fenton Hill, we hope that there will be a more direct involvement of energy companies.

How does DOE see HDR and how fully does it support the program?

The HDR project has been a major program of the AEC, ERDA, and DOE, in succession, in the geothermal area and in general we have had good support from them. Of course we have never had as much funding, or been able to afford as much manpower as we would like, but this is not peculiar to geothermal energy; it's typical of any R & D program.

What is the situation on the proposal from Union Oil and the Public Service Company?

As far as I am aware, the plans are firm for Union Oil and PNM to develop a 50 megawatt geothermal energy plant on the Baca location within the next few years. It will be a system based on the hot water that has been discovered in Union Oil wells west of Redondo Peak. The companies appear to have an excellent supply of very hot water and it should be a successful operation.

What does the budget look like for the next fiscal year?

It doesn't look particularly hopeful. For the fiscal year 1980, we have been told that the total budget for the Division of Geothermal Energy of the Department of Energy is going to be very tight, and that will be reflected in the funding we get. We don't know any amounts yet, but we hope the Lord will look kindly on us and the present plans will be changed; but we don't know that they will.

Can you give a simple breakdown on how the money will be spent?

A very large amount of it will go to the continued development of and experiments at Fenton Hill, particularly the completion of the new, deeper, hotter system. Elsewhere, however, we will be involved in the exploration of interesting areas across the United States that might be developed by HDR methods.

How much would an HDR plant cost?

The cost will vary widely according to where you are, what kind of geology you are in, and what use is

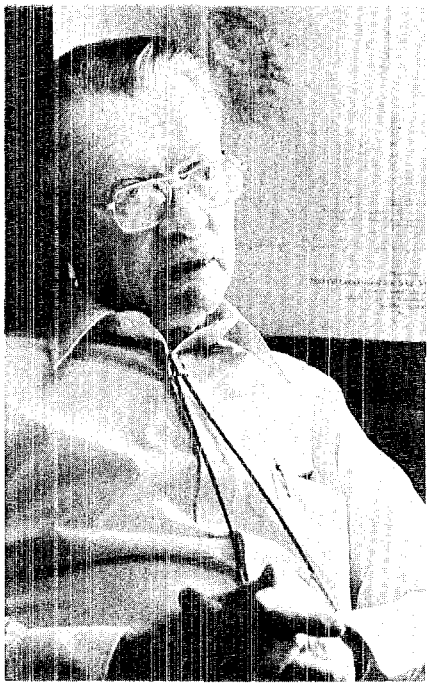
to be made of the heat.... In general, per kilowatt of installed generating capacity (which is how you would estimate it for electrical generation), we expect the cost of a relatively high temperature hot, dry rock system to be about equal, with regard to capital investment, to the cost of a coal-fired plant, for example — and therefore, considerably less expensive than a nuclear power plant. Further, we assume that the maintenance and the operating cost of a geothermal system would be quite low compared to the fuel cost of operating a coal-fired plant, and therefore we expect, on the basis of the best economic studies we can make now, that the economic advantage would be in favor of geothermal even when compared to coal.

If HDR becomes an alternative source of energy, what effect will the public see on their utility bills?

We would hope that their utility bills would not go up as rapidly as they would otherwise; we cannot claim that they would go down.

Concerning the DOE directive that LASL will find alternative sources of energy by the year 2000... does geothermal have a large possibility in becoming this alternative source?

Indeed. I think that the major alternatives we have are the use of coal or of geothermal energy at the Laboratory. The possibility of developing a useful geothermal system here seems to be very good. We are planning, in a couple of months or as soon as a drilling rig is available, to begin a deep exploratory hole in the Laboratory area, and we hope to find a supply of hot water that will be adequate to heat the Laboratory and perhaps even to generate electricity for it. If we don't find hot water, we may try an HDR system to supply the needs of the Laboratory.



'The possibility of developing a system at LASL seems very good. We are planning to begin a deep exploratory hole and hope to find hot water. If not, we may try an HDR system for the Laboratory.'

Thai visitors plan geothermal electric station

By Vic Hogsett

As dollar dials on gas pumps spin faster, and gallon counters slow painfully, it is becoming increasingly obvious that the energy crunch has taken its toll. What is not so obvious is that the problem is worldwide. In response to these dwindling supplies of petroleum fuels, institutions such as the Los Alamos Scientific Laboratory (LASL) have taken on major commitments to develop alternative energy sources.

Firmly aware of these factors, three citizens of Thailand recently toured the Los Alamos Scientific Laboratory with an eye toward development of alternate energy sources for their country. Specifically, they hoped to cull as much knowledge concerning the Federal Hot, Dry Rock Geothermal Energy Development Program as three weeks could permit. This program is managed for the Department of Energy (DOE) by LASL.

Once Chai-Asa Bhotirungsiyakorn (Asa), Tavisakdi Ramingwong (Tavi), and Amnuaychai Thienprasert (Chai) have compiled the desired information, they plan to develop a master plan for an electricity-producing geothermal station. Then, as Tavi said, "We will try to receive funding from our government to develop a working plant. First we have to prove such stations will work in our country."

Electricity demand up

Located between Burma and Cambodia in southeastern Asia, Thailand comprises an area of about 198,000 square miles, roughly the size of Colorado and Utah combined. The country's population of about 45 million receives 60 per cent of its electricity from the United Nations-coordinated Maekont hydroelectric project, located in neighboring Laos. The rest of Thailand's electricity comes from oil- or coal-fired generating stations located within its own boundaries. All together, the country uses about 3,000 megawatts per day (MW/day) of electricity.

Asa, who is with the Electricity Generating Authority of Thailand, said this figure should increase by another 1,600 MW/day by 1984. He explained there are enough proven reserves of lignite coal to provide, after development, another 700 MW/day beginning in 1980.

"In 1977, my country began the development of natural gas reserves," Asa said. "By 1984, we should be producing an additional 900 MW/day from natural gas-fired plants. We have proven reserves of natural gas located offshore in the Gulf of Thailand to provide power on these levels for 40 years."

But, as he quickly pointed out, consumption will rise rapidly along with the country's planned industrial development.

"We can't ensure that this will be enough electricity to meet future needs," Asa concluded.

Tavi, who is an assistant professor of geological sciences at the Chiang Mai University, agreed and added, "For this reason we are trying to have some nonconventional energy sources. Our first, and best, possibility is geothermal development."

He said his country would consider the use of nuclear power plants but added that the international political situation would not allow such development.

According to Tavi, Thailand could ideally foster geothermal development. "We have about 60 hot springs, mostly in the northeast and south, but many located throughout Thailand," he said. "Our study is currently concentrated in the northern portion of our country. In these areas we have located five proposed sites exhibiting a high potential for geothermal power. From these five we will narrow our study to three."

Tavi agreed that the subsurface temperatures in these delineated areas reach higher than 180 degrees C, providing what he calls a "high potential for geothermal power sources." He said much of the heat source rock in northern Thailand is granite with a geothermal gradient from 30 to 70 degrees C per kilometer of depth.

"We feel we can have such energy

Thailand could ideally foster geothermal development. There are about 60 hot springs in the country, and five proposed sites have been located.

Photo by Vic Hogsett

Two of the three Thai visitors who came to visit LASL last month are Tavisakdi Ramingwong, left, and Chai-Asa Bhotirungsiyakorn, better known locally as Tavi and Asa, respectively. Along with Amnuaychai Thienprasert (Chai), they studied the Federal Hot, Dry Rock Geothermal Energy Development Program and hope to help develop a geothermal system for their country. Asa and Tavi toured many of the Laboratory's alternate energy programs; Chai unfortunately was confined to the local hospital with a perforated appendix. The trio adopted Americanized nicknames for the benefit of their Los Alamos friends.

sources," Tavi said. "That is why we are here. We hope to meet people knowledgeable in hot dry rock methods. We have to survey how to do this. After talking to these knowledgeable people, we think the techniques for hot dry rock will be applicable to our proposed program."

He added that if a geothermal program is developed in Thailand, it will be of a different nature than the Federal Hot Dry Rock Geothermal Energy Program headquartered here. LASL's concept involves pumping water deep into fissures surrounded by hot dry rock. There the water is heated and pumped to the surface where the energy can be harnessed. Asa said the Thai proposal would involve converting the energy contained in natural hot water.

Solar, tidal, and others

The third member of the Thai group, Chai, is a geophysicist with the Economic Geology Division of Thailand's Department of Mineral Resources. His study mission was cut short by a bout with a perforated

'We will try to receive funding... first we will have to prove such stations will work in our country.'

'We have an opposite problem — ways to keep cool. That is a little harder to do with solar energy.'

appendix which confined him to our local hospital. Though he and his compatriots were here specifically to survey the possibility of developing hydrothermal power stations, they did not miss the opportunity to briefly study other alternate energy sources.

Aside from touring LASL's geothermal sites at Fenton Hill, the Valle Caldera with Union Oil and Public Service Company of New Mexico officials, and several Geosciences Division groups, the trio was briefed on solar activity at the Laboratory when they spent some time with the Solar Energy Group, Q-11. Tavi said he had hoped to talk to some people from G-7, In Situ Sciences, but found it was impossible because of in-progress testing at the Colony Mine in Colorado. The In Situ Sciences Group is currently most concerned with the development of oil shale as a source of crude petroleum.

Tavi said Thailand has large deposits of oil shale which could be developed. He expressed some reservation over solar development, but said he felt it was a second alternative to geothermal.

"The use of solar energy is very scattered in my country," he said. "There is not a large capital for it.

"Our country is a very warm country," he added. "We have an opposite problem to what you have here — we have to find ways to keep cool. I guess that is a little harder to do using solar energy."

He hinted that an additional Thai study group might visit Great Britain to be briefed on an English study concerned with harnessing the energy in sea tides.

"Depending on what is found out," we foresee this energy might be an addition," he said. "Actually we are trying to catch up on all the alternative energy sources that might be feasible."

Good cooperation

Cooperation appears to be the watchword of the Thai trio's mission. They were here, not as representatives of the Thai government, but as representatives of three Thai institutions concerned with geosciences and energy development. Their trip abroad was not just to our Laboratory, but to New Mexico State University; the New Mexico Institute of Mining and Technology; the United States Geological Survey office in Menlo Park, Calif.; Union Oil, Santa Rosa, Calif.; and to several geothermal power stations in operation in Japan.

Funding for the training mission was provided by the United Nations-sponsored Committee for Co-ordination of Joint Prospecting for Mineral Resources in Asian Offshore Areas, or CCOP.

In short, quite a few national and international institutions had to coordinate in order to make their trip possible. The coordination was dependent upon cooperation and what Asa called, "The history of the very good relationship our countries enjoy."

Tavi and Asa agreed that they certainly appreciated the effort.

"We are very pleased to be here; pleased with the people and the access to information," Asa said. "The Geosciences Division here has been especially helpful."

He added that if funding can be secured, another group of Thai experts would be sent to LASL to study other energy programs.

"We think there is a lot to be learned in Los Alamos," he said. Tavi agreed and added, "We are surprised at the large reservoir of knowledge at the Los Alamos Scientific Laboratory."

One other indicated element of surprise was the friendly attitude of the Los Alamos community, in general.

"People met on the streets here have been friendly, and very happy," Asa said. He added that the ailing Chai had found a similar situation at the hospital, where his appendix was removed.

"He has been very impressed with the doctors and nurses at the hospital," said Asa. "He said he felt the staff was of the highest caliber."

The country uses about 3 megawatts daily. An additional 900 megawatts should come from natural gas-fired plants by 1984.

Photo awards

LASL photographers took several awards at the 20th annual Industrial Photographers of the Southwest Conference, held April 19-20 in Santa Fe. Clockwise, from top left:

Bill Jack Rodgers received 1st, 2nd, and 3rd for best on-the-job black and white for "Helping Hands," "The Window," and "Two."

Eric Johnson, ISD-7, took 2nd in off-the-job color for "Amber Veins."

Sheila Satkowski, ISD-7, 1st in color slides for "Glasstenburg Ct."

Matt O'Keefe, retired from LASL, received Photographers Choice for "A Vision in the Sky."

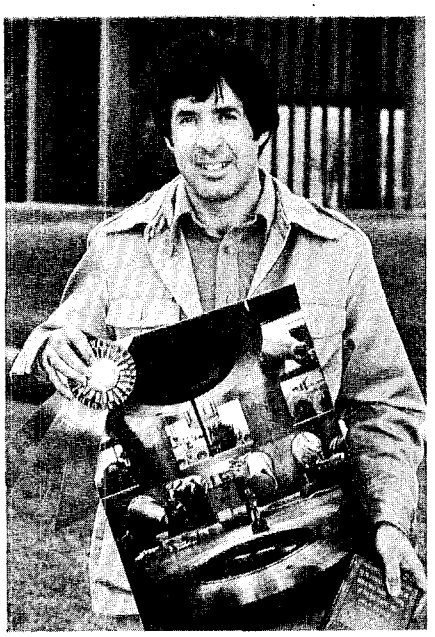
LeRoy N. Sanchez, PUB-1, 1st place in on-the-job color for "Loading Carbide Pellets."

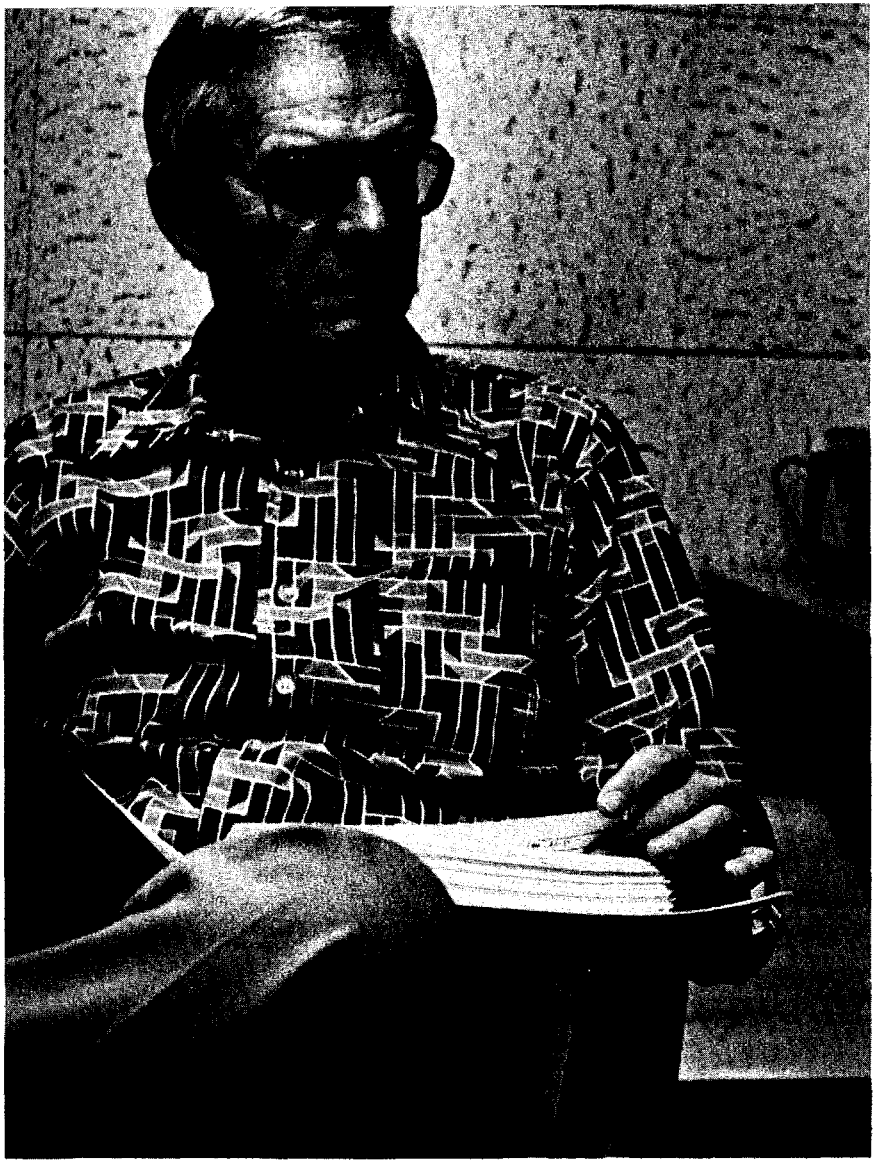
Fred Rick, ISD-7, 3rd place in on-the-job color for "Verifying the Alignment."

Don MacBryde, ISD-7, 3rd place in off-the-job color for "Roots."

Not shown are Rudy Duran, ISD-7, 3rd place in color slides for "Nameless Canyon, Utah;" and Henry Ortega, ISD-7, 2nd place in on-the-job color for "Pulsing Laser Beams" and Best of Show, "Laser and the Lamp."

Photos on this page by LeRoy N. Sanchez, except for his own, taken by John Flower.





Photos by John Flower

"If I could have had a work experience relevant to my major for three or six months when I was going to school, it would have been invaluable." — Robert Anderson, co-op program administrator.

A program that nearly sells itself

By Jeff Pederson

Mary Ann Beckett spends half her time traveling to and working in Washington, D.C. Barry Brown helps analyze data from an experiment at the Nevada Test Site. Phillip Chidester studies sulphur compounds in an environment-related project. Robert Hayes spends much of his time outdoors, tracking local elk. Casilda Trujillo works with uranium recovery in a chemical plant.

These five persons, all undergraduates at New Mexico State University, are spending two semesters each at Los Alamos Scientific Laboratory. They are gaining on-the-job experience that should benefit them when they return to the classroom, and when they inevitably look for career-oriented work.

When the Cooperative Education Program began on a limited basis in 1964, only two chemical engineering students were selected to work for alternating half-year periods in Group CMB-8. The next year, four students came here. Now, Los Alamos is a part time home to 14 students each semester, and the Laboratory must turn away many students who would like to participate.

Part of the interest stems from the pay. Freshmen earn $685 a month, sophomores $740, juniors $820, and seniors $910.

The other reason for success is a program that nearly sells itself. Undergraduates can prepare for jobs related to mathematics, engineering, and the physical sciences, while they determine whether their chosen fields are really the ones that interest them. Educational institutions can evaluate the relevancy of the courses offered in an ever-changing technological environment.

Laboratory groups work with the Personnel Department and give the word when they have a co-op opening. Personnel calls the appropriate co-op coordinator at state campuses, said Robert Albertson, who administers the program with aid from Vicki Kristal. Referrals then come either from university appli-

cant lists, or from "walk-in" job seekers. Promising candidates may be invited to interview here to see whether a mutual interest exists for a position, and an employment offer may follow.

A look at just five of the students now in Los Alamos may give a clearer picture of the Cooperative Education Program.

Mary Ann Beckett

Mary Ann Beckett, a junior majoring in mechanical engineering, is a Los Alamos native who "knew I wanted to work here." She heard of the program at school and now works in Group WX-8. Her travel schedule takes up about half of each month, as she often journeys to Bethesda, Maryland, to gather data for non-power reactor reviews being done by LASL. She has been reading proposed rules for nuclear licensees, and has sat in on reviews involving persons from LASL and the Nuclear Regulatory Commission.

She is also co-authoring licensee documents. "Let's say a group wants to build a nuclear power plant," she explained. "The documents are a kind of cookbook to set up a security plan." Previous technical writing experience has helped her at WX-8, but she's also learned a lot about nuclear power and reactors since she began working here.

"I'll probably go for my master's degree in a nuclear field," she said, noting a change of previous plans.

"Sure, I would recommend this program," she said in response to a question. "This is by far the best place I've ever worked." She also feels an even trade was made by delaying the earning of her undergraduate degree while she receives work experience and gains an advantage when applying for future jobs.

Barry Brown

Barry Brown, a sophomore majoring in mechanical engineering, will return to school this fall and arrive back in Los Alamos in January for a second co-op semester — a typical pattern for program participants.

"This is a pretty big, fairly well-known program at school," he said, even though he did not find LASL's name on a master sheet of co-op offerings at first. "I asked about it, then applied here. The group I wanted had chosen someone else, so I worked in Group WX-1 during Christmas break; then another opening came, and I got to stay."

Brown works with data analysis from pressure cells that have come from the Nevada Test Site. He also does some drafting and design, crafts somewhat new to him.

'This is by far the best place I've ever worked.' 'They give you a job and tell you to go after it.'

Mary Ann Beckett frequently travels to the Washington, D.C. area to gather data for non-power reactor reviews being done by LASL. She works in Group WX-8 and also works with licensee documents.

'Employers are often looking for people with two years' experience. This gives you quite a boost.'

"Everyone is really good about showing me things, and they are patient," Brown said of his co-workers. "They give you a job, and tell you to go after it. Everything's a surprise, in a way, because I haven't had that much schooling yet."

He likes the LASL co-op program, but reflected, "It depends whether a student wants to get through right away, or take the time for a co-op spot. It often means three extra semesters."

Brown, who is helping to calibrate a gas gun's effect on stretch wires used in tests at Nevada, expressed one remaining wish: "I'd like to get out to the Test Site."

Phillip Chidester

A junior majoring in chemical engineering, Phillip Chidester spoke at school with an education counselor who suggested he try Los Alamos. Chidester had relatives here, but had never toured any technical areas.

During his first six-month stay, he worked with a uranium enrichment plant at DP West. "It was kind of scary at first," he recalled. "I was ignorant of radioactivity before. I thought I was in some danger, until I learned more. New Mexico State has a radiochemistry class, but I hadn't taken it."

Now, in his second Los Alamos

Barry Brown, in Group WX-1, helps analyze data from pressure cells that have come from the Nevada Test Site. Part of the work involves calibration of a gas gun's effect on stretch wires.

stay and working in Group CMB-8, Chidester decomposes samples for sulphur dioxide studies. "We see how much sulphur we can get off sulphites and sulphates," he explained. "We run the end product at high temperature, then see how much sulphur dioxide will go the other way and get absorbed by the compound. It's kind of environment-related."

Chidester feels his Los Alamos experience is valuable. "Employers are often looking for people with two years' experience. This gives you quite a boost."

He also encountered "quite a bit of new equipment we usually don't use at school."

Robert Hayes

Robert Hayes, a senior, is majoring in wildlife science. He also is a retired Air Force master sergeant with more than 21 years of military service behind him.

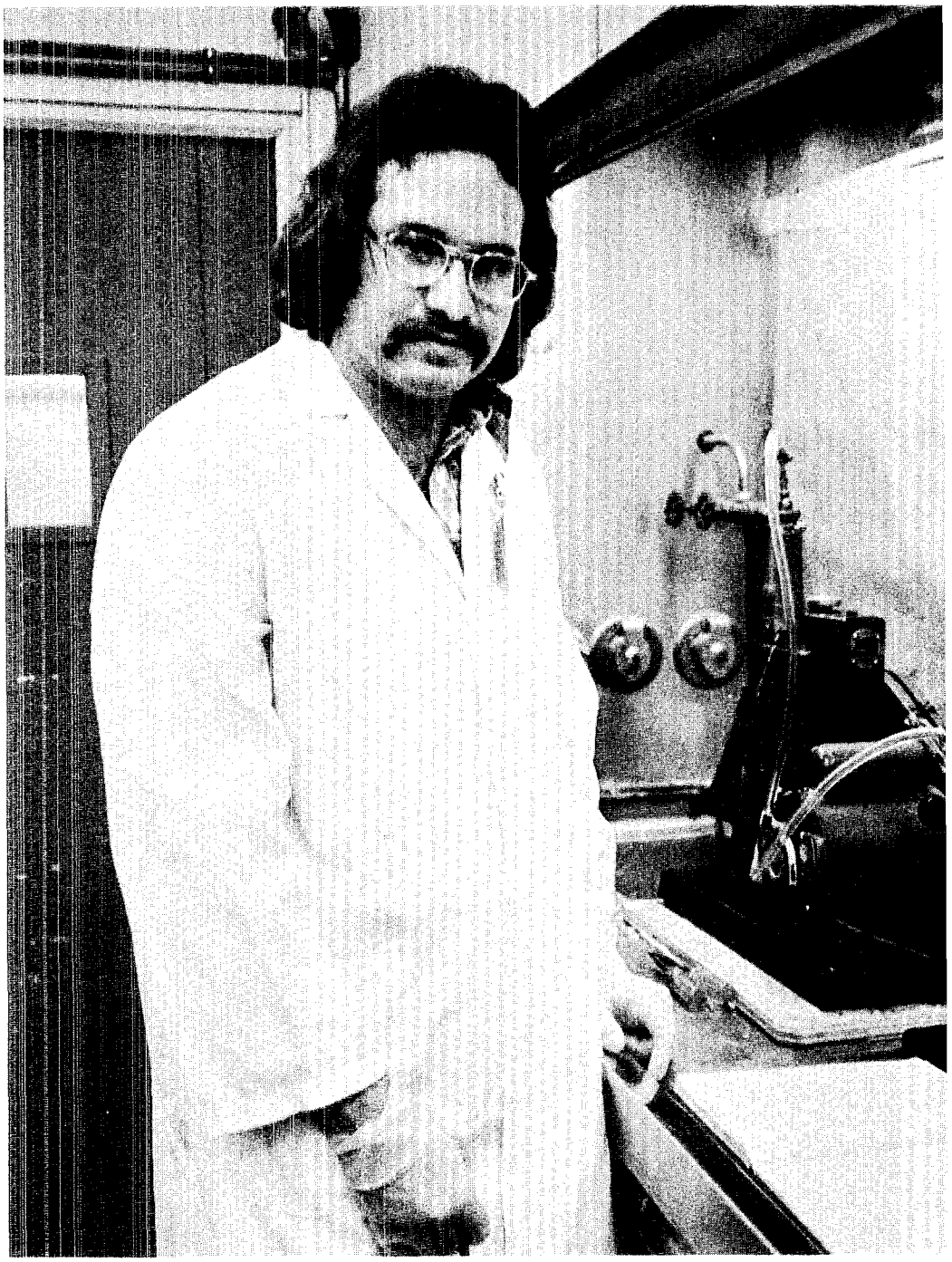
"At State, they put out announcements for applicants," he said. "I talked with my advisor and he mentioned the LASL elk study. I had an Air Force background in electronics, and the study relies on telemetrics, so I applied."

Hayes spends most of his time tracking the elk herd that frequents LASL and nearby lands (see *The Atom*, December, 1978). The outdoor life suits him fine, since he "grew up hunting and fishing."

To plot elk positions, and help determine where they can live comfortably in their environment and with adjacent humans, Hayes uses a telemetric receiver. This decodes signals sent from collars on elk that have been previously tagged.

"It's not all that complicated," said Hayes. "But it's hard trying to follow them." Group H-12 resorts to snowmobiles, four-wheel-drive vehicles, aircraft, and the indispensable human foot.

Before he left the Air Force, Hayes talked over his future with his wife. He decided on a wildlife science career, and hopes for a field position with a government agency, such as the U.S. Fish and Wildlife Service. Private companies, with their requirements to file environ-



Phillip Chidester decomposes samples of sulphur dioxide in Group CMB-8 in environment-related tests. In his first semester at Los Alamos, he worked in a uranium enrichment plant.

When the Cooperative Education Program began in 1964, only two students were selected to work here. Now, 14 are residents each semester, and many more must be turned away.

mental impact statements, are also potential employers, he pointed out.

Climbing mountains is a bit of a challenge to Hayes, who has a fear of heights. Otherwise, he said, "This gives a person a lot of on-the-job training. That's what the program's about. And it works."

Casilda Trujillo

Casilda Trujillo, a junior majoring in chemistry, heard about the program at school and applied. She has an uncle and aunt in Los Alamos and was familiar with the area.

"I'm enjoying it, and learning a lot, and much of the machinery is new," she said. "Much of this is plant work (at Group CMB-8), to recover uranium from scrap projects. I hadn't worked with uranium before. Everything is pretty safe, with the coveralls, booties, gloves, and procedures."

In January, Trujillo will have a research post. And before she finishes the present semester, she will see more of laboratory work. "I'm more or less observing now," she said. "There are so many things to discover and learn yet."

Of her coworkers, she said, "If you don't understand something, they're more than willing to explain. I feel free to ask any questions.

"I got interested in chemistry in high school," she continued. "But until Los Alamos, I'd never been in a chemical plant before."

Since 1964

Albertson said, "The impetus to get the program going was from the schools. It's a good program for schools as well as employers. They can attract students better when the students can work part time and study part time.

"It's not a matter of our soliciting applicants; we work with schools on referrals. Otherwise, we could end up with an abundance of candidates. We just can't take more than a limited number each semester, due to restrictions in program personnel ceiling."

Each student is required to submit an evaluation at the end of the

Robert Hayes, Group H-12, tracks elk with a telemetric receiver that decodes signals sent from collars on tagged animals. Retired from more than 21 years in the Air Force, he is beginning a new career.

Between semesters, students are put on casual employment status. This allows them to work during academic holidays, and bypasses the need for another security clearance in some cases.

Casilda Trujillo hadn't worked with uranium before; at Group CMB-8, she now helps recover the element from scrap projects. She will have research and laboratory positions, respectively, in the program.

program, and LASL must evaluate the student for the university. The Laboratory works most intimately with the University of New Mexico (Lonnie Theye); Eastern New Mexico University (JoAnn Sarracino); New Mexico Highlands University (Consuelo Juarros); New Mexico State University (Maurice Hamilton); and New Mexico Institute of Mining and Technology (Clay Smith).

"Rather than terminate their employment between semesters," said Albertson, "we put them on casual employment status. They frequently work during academic holidays anyway, and this way we don't have to start a new clearance procedure for those who require security access."

There have been nearly 200 students in the LASL Cooperative Education Program since 1964. There is a dearth of hard statistics regarding how many undergraduates later entered government laboratories, or how many benefitted financially from their semesters. But there's no doubt the program has been of assistance to many students.

"I think it's a fantastic opportunity for an undergraduate," Albertson offered. "If I could have had a work experience relevant to my major for three or six months when I was going to school, it would have been invaluable."

Freshmen earn $685 a month, sophomores $740, juniors $820, and seniors $910.

Co-op students now with LASL

These undergraduates are currently enrolled in LASL's co-op program:

University of New Mexico
Gunther Baumbartner, H-7
Jeff Hatchell, H-7
Paul Habholz, G-3
Stephen Rose, CTR-9
Mark H. Smith, WX-8
Peter Stromberg, Q-11

New Mexico State University
Mark D. Beckett, Q-11
Mary Ann Beckett, WX-8
Barry Brown, WX-1
Phillip Chidester, CMB-8
Timothy Farmer, WX-7
Robert W. Hayes, H-12
Paul Littleton, WX-8
Casilda Trujillo, CMB-8
Duane Vigil, WX-7

Eastern New Mexico University
Johnny Collins, C-3
Mari DeBruin, ISD-4
Ricardo Garza, ISD-4
Bobbie Russell, C-3

New Mexico Institute of Mining and Technology
James E. Rice, H-8
Charlene Wardlow, H-8

New Mexico Highlands University
Brenda Vigil, H-11

Short subjects

May 1, 13 journalists and press-related persons visited LASL in a tour sponsored by the non-profit Friendship Ambassadors Foundation. They were from Nepal, Mauritania, the Philippines, Sierra Leone, Tanzania, the Sudan, Fiji Islands, Brazil, Papua New Guinea, the Soviet Union, Nigeria, and Ghana. The visitors' coast-to-coast tour involved discussions with American journalists, energy experts, and political figures.

* * *

The Supply and Property (SP) Department here has earned a special commendation from the Department of Energy. Kenneth Braziel, Los Alamos Area manager, said the Laboratory made an "excellent" showing in a review of its procurement activities. In March, commercial contracts accounted for expenditures of $10.4 million, of which $5.4 million was in contracts for more than $25,000.

* * *

Three films produced by LASL's motion picture and television group (ISD-9) have been selected to receive CINE Golden Eagle certificates. The awards are by the Council on International Non-theatrical Events, and they allow the films to be placed in international competition as representative of the best of American films. The films are "Infinity's Child," on the subject of computer graphics; "The Search for Understanding," dealing with the meson physics facility at Los Alamos; and "Electronic Tagging of Livestock," which traces the use of subdermal transponders and readout devices used in animal identification. These and other films are available for loan; they are unclassified and may be borrowed from the LASL Classified Report Library.

* * *

A Speakers Bureau of qualified scientists and administrators has been established at LASL. The goal is to fulfill requests from other institutions for guest lecturers on Laboratory research and technology. The bureau is administered by the LASL Public Relations Department. A handbook will soon be available to explain the bureau's services and to list major LASL programs. Some current topics include biological research, computers, environmental programs, geosciences, inertial confinement fusion, laser technology, nuclear chemistry, reactor technology, solar energy, nuclear physics, space physics, and weapons.

* * *

Louis Rosen, leader of the Medium Energy Physics (MP) Division, has been named vice chairman of the American Physical Society's Panel on Public Affairs. He will hold that post for a year, after which he will become the panel's chairman. The purpose of the panel, he said, is to respond to requests from state and federal agencies on technical problems that face the nation. Rosen was also the guest speaker May 12 at the University of New Mexico Health convocation, held for 300 graduates in health service disciplines. His topic was, "The Limits of Science and Technology in Health Care Delivery." The same day, Rosen was one of three persons given honorary degrees by the University. The honorary doctor of science recognition was for his contributions to atomic research in many facets. He leads the division that operates the Los Alamos Clinton P. Anderson Meson Physics Facility here.

* * *

Two persons who were closely tied for years with LASL received honorary doctorates May 13 from the College of Santa Fe. Dorothy S. McKibbin managed the LASL Santa Fe office from 1943 to 1963, and was one of the Laboratory's first employees. From her office on East Palace Avenue in Santa Fe, she was the first contact for the scientists, technicians, and military personnel en route to the secret "Project Y." She later managed an information program for LASL employees living in Santa Fe. The other recipient is Harold M. Agnew, former Director, who went to General Atomic Corporation as its president in March of this year. He joined LASL in 1943, after having worked on the first atomic pile with Enrico Fermi's team in Chicago in 1942. Agnew flew as scientific advisor on the Hiroshima strike and went on to a variety of LASL positions, culminating in the directorship, which he held from 1970 to 1979.

* * *

An error in the May, 1979 issue of The Atom attributed photographs from the "Custom Electronics" story to Bill Jack Rodgers. The photos were actually taken by LeRoy N. Sanchez; they accompanied Charlie Mitchell's story on Group E-2.

* * *

Photo by Bill Jack Rodgers

Wolman: escape to other problems

2 billion 'half dead'

A noted sanitary engineer invited a LASL colloquium audience to escape with him from the usual problems which confront them to the problems confronting 2 billion of the world's population.

Abel Wolman, Johns Hopkins University, said he has spent much of his life dealing with the problems, usually health related, of the populations of less developed countries. He began his carrer in 1913.

"The crust of civilization is very thin in those (less developed) countries involving approximately 2 billion people," Wolman said. "This is a population half starved, half clothed, half sheltered, half dead. This is a generality, but like all generalities it is partly true."

In giving his talk, entitled "Endangered Species: The Other Two Billion People," Wolman pointed out that often we are concerned with saving such endangered species as the small darter fish, or protecting our environment through such actions as banning DDT.

"I have a peculiar responsibility of recovering the sense of equilibrium as to what is in danger," he said. To illustrate his point he added that there are about 100 million known cases of malaria in the world, some of them in the United States. Banning DDT has increased the morbitity and mortality rates, due to malaria, within the population of the less developed countries. Since DDT was banned, the World Health Organization has examined nearly 1,400 substitutes to DDT with no success.

"We forget that DDT has saved more lives than anything the EPA has done," he concluded.

Wolman offered an "index for the physical quality of life" which he said is composed of three parameters: life expectancy at birth, infant mortality, and literacy.

He offered quantitative examples of his qualitative parameters. He said the life expectancy in most of the less developed countries is often less than half our own, currently about 72 years. The infant mortality rate within the population of 2 billion is about 50 million per year. This high rate of deaths among youth less than 5 years old is caused chiefly by malnutrition, he added.

"Everyone is half starved in these countries; a great many die, children particularly," Wolman said. Being undernourished leaves these people particularly susceptible to infectious diseases. Speaking of diseases he added, "These 2 billion people have something of everything." These sorts of things leave "young children recipients of every known parasitic organism that may exist." He said there are about 800 million people with hookworm; 400 million suffering from trachoma, caused by flies harbored in the eyes of sleeping young; 250 million with schistosomiasis, passed to humans from snails contained in irrigation water; and 40 million suffering from onchocerciasis, river blindness. He added that in the countries affected by onchocerciasis, people in their twenties are considered the elders.

Concerning the literacy rate of the less developed countries, Wolman said it is rare for the young of the 2 billion to make it to the 4th or 5th grades. Tied to the literacy rate, and itself a good indicator of the quality of life, is the per-capita income of some of these nations. He said it is often as low as $100 per year.

He said another major cause of problems within these countries is the lack of planned families. But, he said, "This is one of the easy ones." Many of these countries have a lower birthrate than the United States.

"What do we do about all of this?" he asked. Aside from encouraging planned parenthood, he said reporting and statistical gathering must be bolstered. Wolman said he asked several knowledgeable people in India how many villages there are in the country. He was given answers from 500,000 to 900,000. He hinted that if these people didn't know how many villages there are in the country, they couldn't know the extent of disease and malnutrition.

A third solution could be found in immunology, he said.

"There is hope that a vaccine will be made available for malaria and this good old disease, schistosomiasis (which he called one of our greatest plagues)," Wolman said. "There have been great strides made in the field of immunology.

"There is no universal approach to the problem, however," Wolman concluded.

Wolman has been active in studies concerned with public health, sanitation, and the environment since 1913 when he began work with the U.S. Public Health Service on studies of stream pollution in the Potomac River. Since then, he has been a consultant or member of over 50 national and international boards, commissions, or universities concerned with environmental impact, health, and sanitation studies. He has been an active member of the Advisory Committee on Reactor Safeguards, and the World Health Organization. He is a member of the Academy of Engineering.

— Vic Hogsett

10, 15, 20 years ago

20 years ago

Tenth county anniversary

Ten years ago this month, June 10, 1949, Gov. Thomas Mabry signed a bill establishing Los Alamos as the state's newest and smallest county. The bill set aside a previous state ruling that prohibited persons living on government land from voting. Later, in 1955, lawmakers made Los Alamos a Class H instead of a sixth-class county. That gave The Hill, the only Class H county in the state, senatorial representation in Santa Fe. Population in Los Alamos is now 13,200.

Commuter bus for NTS

Daily bus service between Las Vegas and Jackass Flats at the Nevada Test Site has started for Laboratory employees. Operated by EG&G, the bus leaves Las Vegas at 6 a.m. and arrives at NTS shortly before 8 a.m. Commuters arrive back in Las Vegas about 6:30 p.m. The bus has air conditioning and reclining seats. An enterprising traveler is providing coffee and rolls en route at a dime a head.

A royal welcome

Three weeks of preparation preceded the visit of King Baudouin of the Belgians. He arrived 20 minutes early, so there was a mad dash by the press, American and Belgian, from a press conference to the airport just as the fleet of Carco planes touched down. Another tour visitor was Gov. John Burroughs, seeing the Laboratory for the first time.

15 years ago

Weirdest wires in town

For 12 years, civil engineer Walt Humphrey of Zia has helped to locate buried metal as new construction takes place in Los Alamos. His detectors are two metal wires, bent into "L" shapes. When the wires turn in his hands and the ends point at each other, this is his signal. The strange thing is, he's almost always right. The men with whom he works attest to his record of success.

New national park?

A bill to establish a new national park is being co-sponsored by Sen. Edwin Mechem (R-NM) and Sen. Clinton P. Anderson (D-NM). The plan would combine 31,000 acres of private land in the Baca Grant with 30,000 acres from the existing Bandelier National Monument. Owners of the 100,000 acre ranch, however, have already turned down an offer of $6.5 million, said James P. Dunigan of Abilene, Texas.

No White Rock airport

A proposal for a White Rock airport has been unanimously rejected by the county planning commission. An additional request by the Los Alamos Aeronautical Association, however, will be presented at the next meeting, and will cover expansion of the present runway in Los Alamos.

Culled from past issues of the *LASL Community News*, the *Los Alamos Monitor*, and *The Atom*.

10 years ago

Return to Bikini

In the spring of 1946, the people of Bikini Atoll sailed into exile, leaving their lovely islands for use by the United States as a nuclear testing site. Last August, their dreams of return ended when President Lyndon Johnson announced their homeland was once again safe for human habitation; testing ended in 1958. Cleanup is now underway, at a total estimated cost of $3 million. An estimated 530 persons have land rights on Bikini and 330 of them now live on Kili.

Airglow and cosmic ray mission

A LASL team conducted an airglow and cosmic ray mission on a series of flights from Sidney, Australia, last month. Data gathered on cosmic rays and airglow — a faint atmospheric light akin to the auroras — will add to scientific understanding of the structure of the upper atmosphere. Two crossings of the magnetic equator were made to provide further observations as to whether the equator shifts with the solar cycle, as has been suggested.

Highest reactor temperature

The highest temperature yet attained in a closed cycle nuclear reactor has been reached in UHTREX, the Ultra High Temperature Reactor Experiment. UHTREX is now operating at an outlet gas temperature of 2,400 degrees F, exceeding by 1,000 degrees F that of any contemporary reactor that uses a recirculating coolant. UHTREX is fueled with 11.4 kilograms of enriched uranium.

Programs in the Department of Energy, came here in May with a small group of DOE headquarters personnel to give an overview of planning, manpower constraints, and budget considerations. He was formerly with Lawrence Livermore Laboratory.

Photo by Bill Jack Rodgers

Among our visitors

Antonius Frinking, member of parliament from The Hague, The Netherlands, discussed laser fusion at the Helios facility with L-Division Leader Roger Perkins during a Laboratory visit. Frinking also heard of nuclear safeguards, weapons work, and the meson physics facility.

Photo by LeRoy N. Sanchez

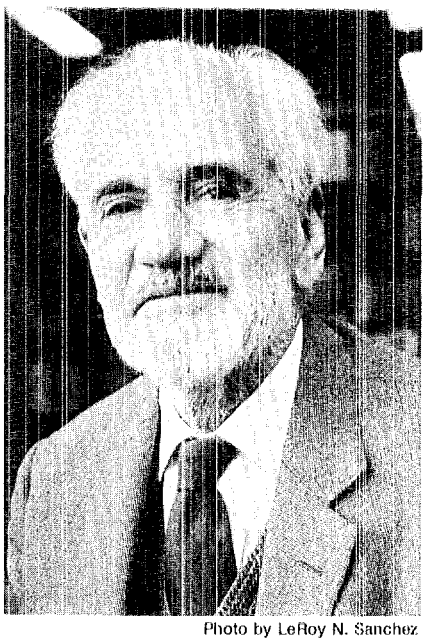


Photo by LeRoy N. Sanchez

Otto Frisch, who has been called "The father of fission energy," visited the Laboratory to give a special colloquium to members of T-Division and P-Division. One of the original scientists at Los Alamos during the wartime years, Frisch is affiliated with Trinity College, Cambridge, England, and is a British citizen.

Photo by LeRoy N. Sanchez

Thirteen journalists, educators, and information representatives from around the world visited LASL as part of a 35-day tour of the U.S. this spring. They were sponsored by the Friendship Ambassadors Foundation and were nominated by U.S. embassies. Here, John McHale of the Public Relations Department gave a tour at the meson physics facility.

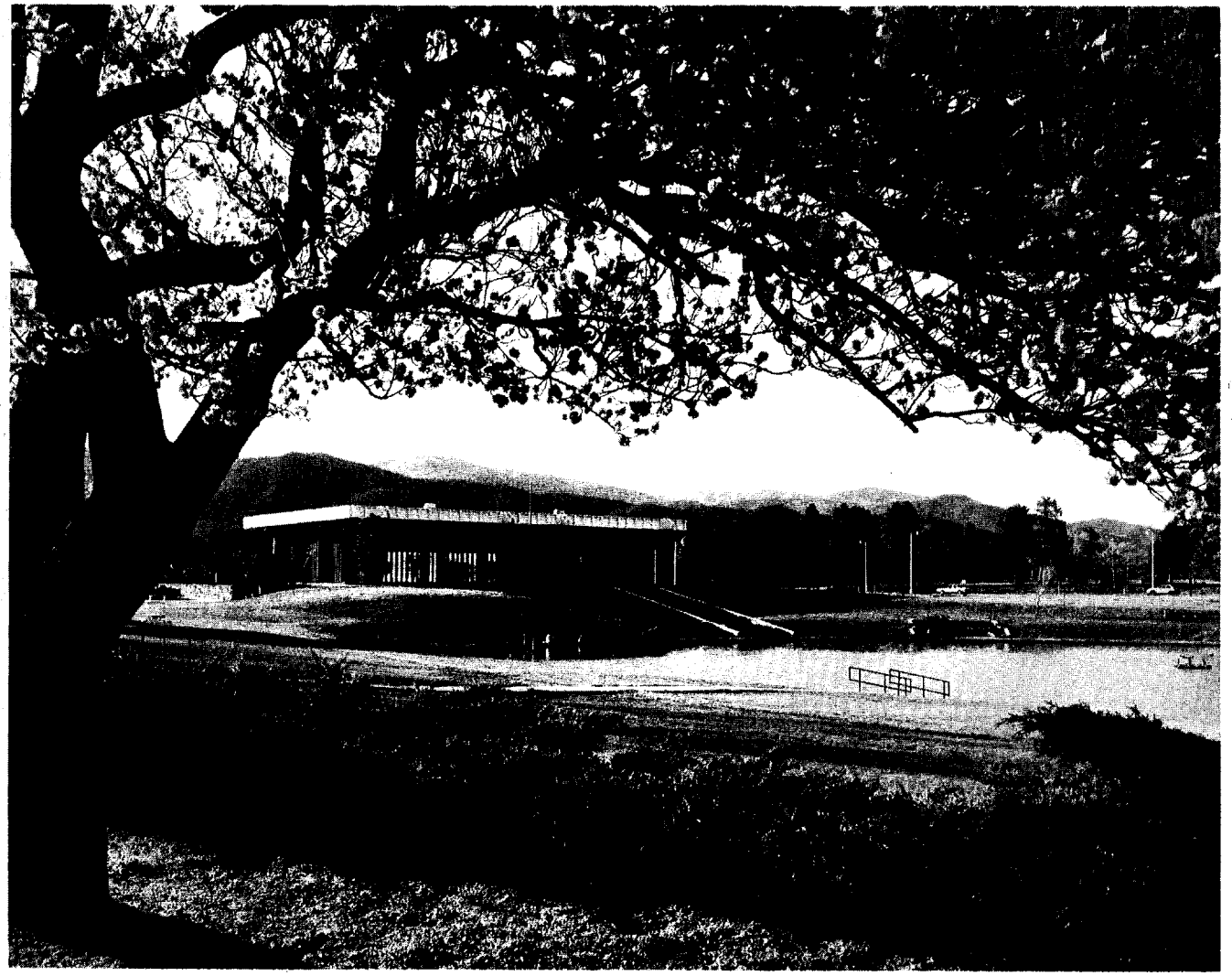


Photo by Bill Jack Rodgers

Blossoms surrounding Ashley Pond signal the advent of spring in Los Alamos, and the departure of the final snows.